

***EVALUATION OF THE TENSILE AND PEEL BOND STRENGTH OF THE
SILICONE AND ACRYLIC SOFT LINER FOLLOWING DENTURE BASE
SURFACE TREATMENT– AN IN VITRO STUDY***

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CERTIFICATE

This is to certify that the dissertation titled ***EVALUATION OF THE TENSILE AND PEEL BOND STRENGTH OF THE SILICONE AND ACRYLIC SOFT LINER FOLLOWING DENTURE BASE SURFACE TREATMENT– AN IN VITRO STUDY***” is a bonafide record of work carried out under our guidance by **Dr. V.HARISHNATH** during the period of 2004-2007. This dissertation is submitted in partial fulfillment of the requirements for the degree of Master of Dental Surgery awarded by The TamilNadu Dr. M.G.R Medical University, Chennai in the branch of Prosthodontics. It has not been submitted partially or fully for the award of any other degree or diploma.

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INTRODUCTION

Denture soreness with associated pain is one of the most alarming situations seen in complete denture wearers. The predisposing causes for denture soreness may vary and depends upon fabrication of the prosthesis and bio-acceptability of denture bearing and supporting tissues. Technical errors such as over extension and under extension of prosthesis can be well managed by correcting these errors.

Denture soreness, which occur due to tissue intolerance to the denture particularly in chronic systemic disorders such as diabetes mellitus. Mere correction of the technical errors alone will not be much helpful to treat the denture soreness due to hard acrylic resin bases in debilitating patient. Hard acrylic denture bases are liable to stress the mucosa beyond its physiological levels of tolerance leading to inflammation and resorption. Excessive resorption of the residual ridges may cause impairment of stability of the denture bases, which is accompanied by soreness, pain and discomfort to the patient masticatory system.

Hence it becomes mandatory to the Prosthodontist and dentist to introduce a suitable material on the tissue surface of the denture to overcome undesirable clinical situation of denture wearers. Soft resilient liners are an important adjunct in the treatment of removable partial and

complete denture patients particularly those who are medically compromised.

The use of resilient soft liners are helpful in fabricating removable complete and partial dentures due to their ability to alleviate inflamed mucosa, resulting in a more equal distribution of functional load to the denture bearing tissues and improving the retention of the prosthesis^{16,24}.

Soft resilient liners have been used for more than a three decades in dentistry; the resilient liners can be categorized according to their chemical structures as plasticized acrylic resin using chemical or heat polymerization, vinyl resins, polyurethane, and polyphosphazine and silicone rubbers^{1,8}.

The basic chemical natures of silicone soft liners are entirely different from acrylic soft liners. Silicone soft liners are not dependent on leachable Plasticizer and therefore it retains their elastic properties for prolonged periods. The soft liners have a key role in modern dentistry because they act as a cushion for denture bearing mucosa through absorption and redistribution of forces⁸ transmitted to the stress bearing areas of the edentulous ridges⁴². They provide comfort⁴² to the patients who suffer from compromised residual ridges and other debilitating conditions such as highly resorbed ridges, debilitating disease,

osteoporetic conditions, sharp bony spicules, thin atrophic mucosa, bony undercuts and poor fit of the denture base.

The longevity of the soft liner varies ranges from 6 months to 5 years depending on the type of material used. If a soft liner serves for more than two years it can be considered as successful one for prevention of denture soreness and preservation of supporting hard and soft structures.

However one of their major drawbacks in silicone soft liners is the lack of durable bond to the denture base resin. The bond between the heat polymerized acrylic resin and the silicone soft liners failed quite often⁴⁰ requiring repeated relines. This failure results when the soft lining material swells due to water sorption leading to stress build up between the interfaces of denture base and liner or the viscoelastic properties of the materials may change. The material becomes brittle and transfers the external load to the bonding area thus leading to bond failure. This weakened bond between the silicone reliner and denture base resin encourages the ingress of oral fluids and microorganisms at their junction and leads to staining, compromised denture hygiene and facilitates the detachment of liner from the denture base.

Hence understanding the chemistry of the bonding of soft liners with acrylic resin along with the nature of the bond and mechanism of

bond failure will help us in overcoming the problem and rendering better service to patients who are to be rehabilitated by removable prosthesis.

Various workers have done evaluation of the bond strength of the soft liner by subjecting them to a variety of studies, which include peel, tensile, shear bond strength and creep test.

The present study was conducted to evaluate the peel and tensile bond strength of some of the commercially available soft liners following denture base resin surface pretreatment with methyl metha acrylate. In addition to this to evaluate the surface topography of the heat cure acrylic denture base samples before and after surface pretreatment with methyl metha acrylate by scanning electron microscope.

AIMS OF THE STUDY

1. To study the tensile and peel bond strength of the auto polymerized acrylic and silicone based soft liners bonded to the heat cure acrylic denture base whose surface is pretreated with methyl methacrylate.
2. To study the tensile bond strength of the auto polymerized acrylic and silicone based soft liners bonded to the heat cure acrylic denture base.
3. To study the peel bond strength of the auto polymerized acrylic and silicone based soft liners bonded to heat cure acrylic denture base.
4. To study the surface topography of the heat cure acrylic denture base before and after surface pretreatment with methyl methacrylate by scanning electron microscope.

REVIEW OF LITERATURE

Complete denture wearers are commonly prone for denture soreness following the insertion of complete denture. The predisposing causes for denture soreness may vary and depends upon fabrication of the prosthesis and bio-acceptability of denture bearing and supporting tissues; Technical errors such as over extension and under extension of prosthesis can be well managed by correcting these errors.

Denture soreness which occurs due to tissue intolerance to the denture particularly in chronic systemic disorders such as diabetes mellitus have to be treated with different approach. Mere corrections of technical errors will not be much helpful to treat the soreness.

Hence it became mandatory to the Prosthodontist and dentist to introduce a suitable material on the tissue surface of the denture to overcome this undesirable situation of denture wearers. Different materials such as velum rubbers tissue conditioners and soft resilient liners, which are of soft constancy were tried to solve this problem. Several workers involved themselves to find out a material to meet the clinical demands.

In (1977)¹⁴ **Gonzalez JB**. The application of elastomer polymers in the prevention and treatment of chronic tissue irritation from dentures is an excellent alternative to the use of hard polymer resins and it is useful for

preserving the health of the remaining denture-supporting tissues. Wider applications will be found in the future once the present shortcomings of the available materials are overcome, whether by improving these materials or by developing new ones. Specific uses for these materials have been outlined with awareness that the readers may be able to add other applications to the list. At the same time, it is not the intent of this article to imply that the use of elastomer polymers is the panacea for all prosthodontic problems or that fundamental principles can be neglected.

In (1983)⁴⁷ William F. Schmidt and Dale E. Smith conducted a six- years retrospective study investigation into the serviceability of Molloplast-B-lined dentures. Within limits of this study, the authors concluded that the longevity of the soft liner is dependent on correct processing procedures and proper home care, the resiliency of the liner is dependent on its thickness and the resiliency of the liner did not decrease with time.

In (1992)³⁶ Polyzois GL compared the adhesive strength of three resilient denture-lining materials with different chemical compositions when bonded to visible light-cured (VLC) denture base resin. Within limits of this study, he concluded that all of the lining materials were acceptable for clinical use but that water storage reduced their bond strength to VLC resin. He also found that the light cured materials showed greater bond

strength to traid resin but that their water storage reduced the bond strength of liner.

In (1992)⁴¹ Sinobad D evaluated the bond strength and rupture properties of three soft acrylic liners. The results of the study indicated that denture soft liners had variable water sorption values depending on their basic structure, and some properties changed after immersion in water, a finding that is of relevance to prosthodontic practice

In (1993)³⁹ Robert W. Loney evaluated the effect of finishing and polishing on surface roughness of a processed resilient denture liner. Within limits of this study, the authors concluded that without polishing, the burs produced rougher surfaces than stones and required longer times for reduction, and bur samples also remained rougher than stone samples after pumicing but no significant differences were found between treatments or controls after the use of either a combination of pumice and tin oxide or tin oxide alone.

In (1993)²² Jepson et al evaluated the viscoelastic properties of a widely used temporary soft lining material have been monitored in vivo and in vitro using a force distance probe. They observed that over a period of 8 weeks clinical use, Coe soft demonstrated a significant and continued

reduction in compliance with time, the reduction being particularly rapid over the first week and all reductions in compliance were significantly less than those seen clinically.

In (1994)¹⁷ Hiroki Nikawa et al investigated the deterioration of six commercially available resilient denture-lining materials immersed in seven groups of denture cleansers. Their results suggested that various components of denture cleansers and soft lining materials, particularly peroxides, in cleansers & gel formation components of soft liners, played an important role in the deterioration of soft liners caused by liners.

In (1994)³⁵ Omer Kutay, evaluated the bond strength characteristics of resilient liners by means of 180° Peeling and butt tensile strength testing. He found that the mode of failure of Molloplast-B and Novus liners were significantly differs between the tensile bond and peel bond test methods. Within the limitations and based upon the results of the study, the authors came to conclusion that bond strength characteristics varied according to the test method used.

In (1994)¹⁰ Fumiaki et al evaluated the cushioning effect of soft denture liners with the use of a free drop test with an accelerometer. The materials tested included Super soft, Kurepeet-Dough, Molteno soft and Molloplast-B brands. Based on this study author concluded that

Molloplast-B and Molten soft materials showed excellent shock absorption. They also concluded that the aging of all materials also affects the cushioning effect.

In (1994)²⁷ Moodhy et al compared the bond strength of some of the commercially available heat cured denture soft lining materials to various denture base resins. Their result showed that the bond strength of Coe super soft (acrylic soft liner) and Molloplast-B (silicone soft liner) were greater than the shear strength. Coe super soft specimens had the highest shear strength values indicating high bond strength. The bond strength of Novus (fluoro elastomer) was dependent on the denture base material, and was greatest with Ts 1195(denture base resin).

In (1994)⁴⁶ von Fraunhofer JA, The physical and viscoelastic properties of two resilient denture liners, the polyphosphazine-based Novus and silicone-based Molloplast b, have been characterized. The two materials were found to have comparable tensile strengths and frictional properties but differed in their tear strengths, water sorptions, and solubilities. Novus had a greater tear strength and lower solubility, but greater water sorption, than Molloplast b. Compressibility studies indicated that significantly less force was required to compress 2- and 3-mm thicknesses of Novus by 0.2 and 0.4 mm than for Molloplast b. Dynamic

mechanical analysis indicated that Novus should have a greater propensity for energy/impact absorption.

In (1995)⁷ Danielle Buch compared the viscoelastic properties of permaflex to other soft lining materials. Their test provided practical instructions for the use of permaflex, which showed good adaptive properties to stress and surface condition. He found that the application of varnish showed good adaptive properties to stress.

In (1995)⁴⁵ Thomas J.Emmer et al studied the adhesive and cohesive strength of different soft tissue liners bonded to the denture base resin by use of new technique. They concluded that significant differences were observed in the bonding of liners to the denture base resin and that light cure systems exhibited the greatest amount of stress needed for failure.

In (1996)²⁶ Moodhy et al compared the peel, tensile and shear bond strength values of a commonly used heat cured denture soft lining material (Molloplast-B) bonded to a polymethyl methacrylate denture base material and also evaluated the effect of liner thickness and deformation rate on the bond strength. Within limits of this study, the authors concluded that the measured bond strength of Molloplast-B denture lining material to polymethyl methacrylate was affected by the

type of test method, the measured bond strength and mode of failure was affected by both liner thickness and the deformation rate.

In (1996)³⁰ Nanette E.Dominguez found that the life of soft liners could be extended by the use of polymethyl methacrylate coating material (Monopoly). The monopoly coating also prevents the water absorption and Plasticizer loss from an underlying tissue conditioner.

In (1997)¹¹ Fumiaki Kawano et al conducted an invitro study to compared the bond strength of six soft resilient liners processed against polymerized and unpolymerized polymethyl methacrylate surface. The bond strength was evaluated by a two-phase tensile test. Four of six liners demonstrated increased bond strength when processed against polymerized polymethyl methacrylate. Within the limitations and based upon the results of the study, the authors came to conclusion that the bonding could be influenced by processed method.

In (1997)⁴⁹ Yutaka Takahasi conducted a study to evaluate the flexural strength of denture base material relined with four different types of denture reline materials. He also found that the flexural strength at proportioned limit (PL_f) of the reline denture base progressively decreased with an increasing thickness of he reline material.

In (1997)²⁰ Iwao Hayakawa et al examined the intra oral changes of the elastic properties and roughness of tissue conditioners after treatment with fluorinated copolymer coating agent. Within the limitations and based upon the results of the study, the authors came to conclusion that the coating provided an improved glossy surface to the conditioner and may increase its life.

In (1997)²⁹ Nancy et al conducted an invitro study to evaluated the effects of a specific sand blasted or lased preparation on the interfacial bonding of polymethyl methacrylate, silicone and polyethylmethacrylate resilient liners. Within the limitations and based upon the results of the study, the authors came to conclusion that the altering the polymethyl methacrylate surface by sand blasting significantly reduced the peel strengths of the polymethyl methacrylate/polyethylmethacrylate and polymethyl methacrylate/silicone specimens. They also concluded that the mechanical surface preparation of denture bases before application of a resilient liner might not be warranted.

In (1997)¹² Fumiaki Kawano et al evaluated the cushioning effect of soft denture liners by using a free drop test with an accelerometer. Within the limits of this study they concluded that accelerated aging favorably affected the impact absorption of all the soft denture liners.

In (1998)³ Aylin Baysan et al conducted an invitro study to determine whether using microwave energy to activate the polymerization of a silicone rubber denture soft lining material affected its properties. Within the limitations and based upon the results of the study, the authors came to conclusion that the method of polymerization does not compromise the strength of a soft lining materials and its adhesion to polymethyl methacrylate.

In (1998)²⁸ Murata.H et all evaluated the setting behavior and viscoelastic properties of various types of resilient denture liners and the changes in viscoelasticity with the passage of time. They concluded that significant differences were found in the setting behavior of the autopolymerizing materials. The acrylic resin materials exhibited the greatest changes in viscoelastic properties over time when compared with silicone, polyolephin, and fluoroethylene materials.

In (1998)¹³ Furukawa KK et al conducted an two phases of study, in the first phase of study evaluated the effectiveness of 3 minute chlorine dioxide spray and immersion disinfection procedures on 2 denture liners (Coe Soft and Coe Comfort) and stainless steel specimens used as controls. The second phase evaluated the effectiveness of spray disinfection at time intervals of 1,3,10 minutes. Within the limitations and based upon the results of the study, the authors came to conclusion that

the Coe Soft and Coe Comfort denture liners should be removed before entering the laboratory. These materials contain sufficient viable bacteria after routine disinfection procedures to cause contamination of the “clean laboratory.”

In (2000)² Amany EL-Hadary & James L.Drummond, evaluated and compared the water sorption, solubility and tensile bond strength of a newly introduced silicone (Luci-sof) based soft liner and a plasticized acrylic resin soft liner (Permaoft). The results of comparison of the materials in this study indicated that the silicone based soft liner was superior, based on the properties investigated. Its lower water sorption and solubility together with its higher tensile bond strength may provide for better clinical use.

In (2000)³⁴ Olan – Rodrigues L et al evaluated the effect of 2 dentures sealer agents on the microbial colonization of a newly placed soft interim denture liner during a period of 14 days. Within the limitations and based upon the results of the study, the authors came to conclusion that the Coating of Coe Soft denture liner with either palaseal or Mono - Poly significantly decreased yeast and bacterial colonization.

In (2000)³² H.Nikawa et al evaluated the interaction between thermal cycled resilient denture lining materials, salivary and serum pellicles and candida albicansin. Within the limitations and based upon the results of the study, the authors suggest that the ageing of the materials and the biological fluids of the host promote yeast colonization on the resilient lining materials.

In (2000)³¹ Nesrin Anil et al investigated microleakage at the interface of various soft liners and base materials. Within the limits of the study, the authors concluded that silianization of soft liners may be beneficial in reducing microleakage between the soft liner material and the acrylic resin base. However, the reduction effect of sealant on microleakage may change after aging.

In (2001)³⁷ R.N.Rached & A.A.Del-Bel Curyconducted an invitro study to evaluate the influence of chemical surface treatments in the repair strength of a heat cured acrylic resin (Lucitone 550 (LU)). In this study for surface treatment they were used 30seconds methyl methacrylate monomer dipping, 30seconds acetone dipping, 15seconds acetone dipping + blast of air + 15seconds methyl methacrylate monomer dipping and untreated repair surface. Within the limitations and based upon the results of the study, the authors came to conclusion that the all surface treatments achieved a high percentage bond strength to LU denture base

resin, acetone dipping achieved the highest transverse strength when compared with acetone-monomer association and no surface treatment and LU exhibited different surface textures under the treatments studied.

In (2001)²⁵ Leles et al evaluated the effect of six different surface treatments with chemical etchants (1. methyl methacrylate monomer, 2. isobutyl methacrylate monomer, 3. chloroform, 4. acetone 5. experimental adhesive and 6. no surface treatment) on the bond strength between a hard chair sides reline acrylic resin and a heat-cured acrylic resin. Within the limitations and based upon the results of the study, the authors came to conclusion that treating the surface with acetone 550 monomer or chloroform improves the sites bonding, and promoted the highest transverse bond mean values.

In (2001)⁵¹ Yutaka Takahashi & John Chai, conducted an invitro study to characterize the shear bond strength between four denture relining materials and four denture base polymers. The denture base polymers were one conventional heat processed, one microwave energy processed, one pour type autopolymerizing and one light activated denture base polymer. The reline polymers wee two autopolymerizing and two light activated denture reline polymers. Within the limitations and based upon the results of the study, the authors came to conclusion that bond strength between the reline polymers and the light cured denture base resin were

generally lower than those with other denture base polymers and this may be attributed to the highly cross linked nature of this material. The authors also state that these results were not observed in earlier studies and the difference in the method of testing bond strength probably explains the different results.

In (2001)⁵⁰ Yutaka Takahashi & John Chai, conducted an invitro study to evaluate the effect of five surface treatments on the bond strength established between three denture reline materials (Kooliner, Trade VLC Reline and GC Reline) and a denture base resin (Lucitone 199). . Within the limitations and based upon the results of the study, the authors came to conclusion that the bond strength of dichloromethane-treated kooliner was significantly lower than those achieved with Traid–Traid bonding agent and GC reline-denture base monomer combinations. These combinations achieved the highest bond strengths among the various surface treatments of the respective reline materials. Thus it is advisable that Trade bonding agent and denture base monomer be used on the respective reline materials when relining the denture base resin used in this study.

In (2001)⁴³ N. Taguchi et al evaluated the influence of viscoelastic properties of resilient denture liners on the pressures under dentures, a series of creep and stress relaxation tests were carried out using a

simplified mandibular edentulous model and denture model. They concluded that (i) The use of the resilient denture liners is effective for stress relief under dentures. (ii) The thickness increase of each denture liners causes the effect of stress relaxation. (iii) The material exhibited viscoelastic behavior after applying the stress and has the ability to distribute stress or stress relaxation.

In (2002)⁴⁰ A. Sertgoz et al conducted an invitro study of the effect of thermocycling on peel strength of six commercially available silicone resilient lining materials of which four were of autopolymerizable type (Mollosil, Ufigel P, Ufigel C and Permaquick) and two were heat polymerizable type (Molloplast-B, Permaflex). The specific objectives of this study aimed at developing a peeling method to characterize the failure modes to evaluate the bonding and/ or the cohesive strength of selected permanent soft reline materials bonding to a denture base material. Within the limitations and based upon the results of the study, the authors came to conclusion that peel strength of all soft lining materials increased a result of thermocycling except for U figel P and U figel C demonstrated mixed or cohesive mode or failures, with the latter two exhibiting adhesive type of failures.

In (2002)²³ Jose Renato Ribeiro Pinto et al conducted an invitro study to evaluate the effect of thermocycling on the bond strength and elasticity of 4 long-term soft denture liners (two silicone and two acrylic) to acrylic resin bases. The result of this invitro study indicated that bond strength and permanent deformity values of 4 soft denture liners tested varied according to their chemical composition. Within the limitations of this study the tensile test indicated that thermocycling had a deleterious effect on the bond strengths of the soft liners. The permanent deformation test indicated that, regardless of thermocycling, acrylic soft lining materials have more permanent deformation than silicone materials. Thermocycling had a deleterious effect on the permanent deformation of acrylic soft lining materials and did not have deleterious effect on the permanent deformation of silicone soft lining materials.

In (2002)⁴⁴ Tamura F et al evaluated the viscoelastic characteristics of a group of soft denture liners by means of a creep test. Within the limitations of this study the authors came to conclusion that the silicone rubber was as soft as the tissue conditioner and softer than the polyolefin liner. The stiffer the material, the lower the permanent deformation observed.

In (2002)¹⁹ Igor J. Pesun et al conducted an invitro study to measured the junctional gap between two long term, resilient denture liners and a

denture base material after different finishing and polishing procedures were performed. The surface smoothness of the 2 liner materials also was evaluated. Based upon the results of this study the authors observed that larger average gaps were found in the experimental liner (SL-702-2-M, heat polymerized methyl siloxane-resin based material) than in Molloplast-B.

In (2002)²¹ Jagger RG investigate the effect of roughening the denture base surface on the tensile and shear bond strengths of a poly(dimethylsiloxane) resilient lining material (Molloplast-B) bonded to a heat-cured acrylic resin denture base material. They concluded that the roughening the denture base surface prior to the application of Molloplast-B had a statistically significant weakening effect on tensile bond strength compared with the smooth surface and the acrylic resin dough.

In (2003)⁴⁸ Yasemin Kulak-Ozkan et al conducted a study to investigate the effect of thermocycling on the tensile bond strength of six commonly used silicone based soft lining materials (Ufigel C, Ufigel P, Mollosil, Molloplast-B, Prmafix and Permaflex). The bond strength was determined in tension after processing to PMMA. Within the limitations and based upon the results of the study, the authors came to conclusion that thermocycling generally decreased the tensile bond strength and

change the mode of failure to adhesive failures in resilient liner materials. The results showed that the force for failure was 4.5 kg/cm^2 , which is acceptable for clinical use. Considering this criterion, all materials tested had also satisfactory bond strength to the polymerized PMMA denture base resin after thermocycling.

In (2003)³⁸ Renata C.M. Rodrigues et al evaluated the effects of a denture cleanser on weight change, roughness, and tensile bond strength on 2 denture resilient lining materials. Within the limitations of this in vitro study, specimens immersed in polident demonstrated increased weight changes of resilient liners when compared with tap water, but surface roughness and tensile bond strength were unaffected.

In (2003)³³ K.Ohtani et al evaluated the effects of denture surface roughness on peel bond strengths of silicone denture liners. They were used three silicone denture liners, Reline-Soft (GC), Permafix (Kohler), and Mollosil plus (DETAX). Fifty-four acrylic denture base specimens (60x10x10mm) were divided into three groups, and each group received surface treatments including polishing with #2000 grit SiC (Control), grinding with #120 grit SiC (Ground), and air-abrasion with Al₂O₃ (Abrasion). Each denture liner was bonded to the specimens with the dimension of 40x10x4mm. Peel bond strengths (PBS, N/mm) were

evaluated using an Instron universal testing machine at a 50mm/min crosshead speed. Based on the study results the authors concluded that the increase of surface roughness on a denture base might cause a decrease of bond strength of silicone denture liners.

In (2004)¹⁸ Hong G The purpose of this study was to determine the influence of plasticizer content on the tensile bond strength of heat-cured acrylic soft denture liners to a denture base resin. Differences among materials were significant, except for 100 wt% Dibutyl Sebacate (DBS) and 80 wt% DBS of tensile bond strength. The bond strength of all materials to the denture base increased with an increase in thermal cycles significantly except for 40 wt% DBS. The tensile bond strength of soft denture liners to the denture base resin significantly decreased with an increase of plasticizer contents. Differences were found among the difference plasticizer contents in failure types between the denture base resin and soft denture liners. The results suggest that the tensile bond strengths of heat-cured acrylic soft denture liners to the denture base resin were lower with an increase in plasticizer content.

In (2004)⁴² Y. Sinasi Sarac et al conducted an in vitro study to investigate the effect of 2 surface treatments, airborne-particle abrasion and wetting with methyl methacrylate monomer on microleakage between a silicone-

based resilient liner and denture base resin using a gamma camera imaging technique. Based upon this study, the authors concluded that in all experimental groups microleakage was not prevented only reduced microleakage of fluid between a silicone based resilient liner and denture base resin, wetting the PMMA surface with methyl methacrylate monomer was significantly more effective than either airborne particle abrasion with Al_2O_3 particles or resilient liner application without any surface treatment and only adhesive application.

In (2005)⁵ A.V. Naik & J. L. Jabade conducted an in vitro study to determine the tensile bond strength of three commercially available soft liners to a polymethyl methacrylate denture base resin, for to help the clinicians to select the liner for their patients and to provide a comparative database when new materials are introduced. Within the limitations and based upon the results of the study, the authors came to conclusion that tensile bond strength of heat cured acrylic soft liner was better than the silicone soft liners.

In (2005)⁴ Ayse Mese et al evaluated the effect of storage duration on tensile bond strength of acrylic and silicone based soft denture liners to a processed denture base polymer. The denture liners investigated were vertex soft (acrylic based, heat cured), Coe soft (acrylic based, auto

cured), Molloplast-B (silicone based, heat cured). Within limits of this study, the authors concluded that the bond strength of all lining materials decreases with storage duration; the decrease being greatest for the acrylic based soft liners. The decrease in bond strength of the auto-cured material is greater than that of the heat cured products. Comparison of the materials in this study indicates that the silicone based, heat cured soft liner is superior, based on the tensile bond strength property. Use of silicone based, heat cured soft liners may provide better clinical success over a long period.

In (2005)⁹ Fujii K et al evaluated the ease of manipulation and durability of 11 commercially available silicone-based resilient denture liners, extrusion force, hardness, weight change, and bond strength were determined. They concluded that materials exhibited good handling properties--for example, mixing and spreading of material could be done easily. However, some materials exhibited inadequate durability for clinical service, because hardness increased during storage and/or bond strength decreased after thermal cycling.

In (2006)⁸ Duygu Sarac, Y. Sinasi sarac evaluated the effects of denture base resin surface pretreatments with different chemical etchants preceding the silicone based resilient liner application on the micro

leakage and bond strength. 42 polymethyl methacrylate denture base specimens consisting of two plates measuring 30 x 30 x2 mm were prepared and were divided in to seven groups according to the surface pretreatments which they received prior to the bonding of the silicone liner. Specimen groups were treated by immersion in acetone for 30 seconds and 45seconds, methyl methacrylate monomer for 180 seconds, and methylene chloride for 5, 15 and 30 seconds. The group which did not receive any kind of surface pretreatment constituted the control group. Subsequently the silicone liner was bonded to the acrylic resin and tracer activity as a parameter for micro leakage was measured using a gamma camera. For bond strength measurements 84 rectangular P MMA specimens of dimensions 10 x 10 x 40mm were surface smoothed for bonding and treated with different chemical etchants using the same previously described group configuration. Tensile bond strength was measured in a universal testing machine at a crosshead speed of 5 mm/min. The specimens were then observed in a stereomicroscope and failure was recorded as cohesive, adhesive or mixed. Within the limitations and based upon the results of the study, the authors came to conclusion that treating the denture base resin surface with chemical etchants increased the bond strength of the silicone based resilient denture liner to denture base and decreased the micro leakage between the two

materials and the use of methacrylate monomer for 180 seconds was found to be the most chemical effective treatment. In (2006)⁶ Cal E et al investigated the hardness and microbiologic adherence of four permanent soft denture-lining materials. In addition, the adherence of *Candida albicans* and *Staphylococcus aureus* was studied in vitro by quantitative culture method and scanning electron microscopy (SEM). Surface properties of the materials also were observed with SEM. They concluded that the hardness of all materials increased throughout the study.

MATERIALS AND METHODS

The present study was conducted to evaluate the peel and tensile bond strength of some of the commercially available soft liners with denture base resin and the effect of surface pretreatment of acrylic denture base with methyl methacrylate. In addition to this the surface topography of the heat cure acrylic denture base is observed before and after surface pretreatment with methyl metha acrylate by scanning electron microscope

MATERIALS USED

Sl.No	Materials Commercial Name	Type of polymerization	Form of the materials	Manufacturers Name
1	G.C RELINE TM SOFT (Fig.I)	Auto polymerized silicone soft liner	Supplied as cartridge (base & catalyst)	G.C corporation Tokyo. Japan
2	COE – SOFTTM RESILIENT DENTURE LINER (Fig.IA)	Auto polymerized acrylic soft liner	Powder & Liquid	G.C America inc. Made in U.S.A
3	ACRYLAN–H	Heat cure	Powder & Liquid	Asian acrylates
4	ACRYLAN–H	Heat cure	Liquid (For pretreatment procedure)	Asian acrylates

TENSILE BOND STRENGTH

A total of 40 acrylic blocks of dimensions 40 x 10 x 10mm were prepared in heat cure denture base resin. The polymethyl methacrylate blocks were ground with 320-grit silicone carbide paper to remove surface irregularities and excess material. These 40 blocks were then divided into 4 groups

1. Group A
2. Group B
3. Group C
4. Group D

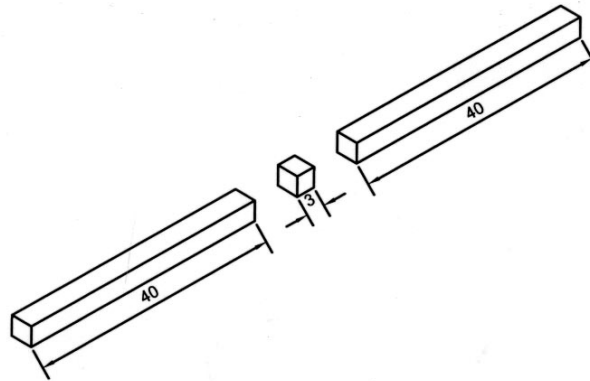
Each group contains 5 samples and each sample consists of two acrylic blocks with soft liner interposed.

- Group A and C samples surfaces were not treated with methyl methacrylate.
- Group B and D samples surface were treated with methyl methacrylate for 180 seconds.
- Auto polymerized silicone soft liner were bonded to group A and B
- Auto polymerized acrylic soft liner were bonded to group C and D

PREPARATION OF THE TEST SAMPLES

DETAILS OF THE METAL DIES (FIG. I):

Two rectangular steel dies for a size of 40 x 10 x 10mm and one steel die for a size of 10 x 10 x 3mm were prepared and all these surfaces were smooth and flat with sharp edges. These steel dies are used to fabricate the acrylic blocks and soft liners blocks respectively.



PREPARATION OF HEAT CURED ACRYLIC BLOCKS:

Mold space was created from steel dies size of 40 x 10 x 10mm by using addition silicon putty material (Fig. II). Wax blocks were prepared by pouring the molten wax into the mold space. A total number of 40 wax patterns were prepared (Fig. III).

The wax patterns were then flaked by conventional technique. After the dewaxing procedure, heat cure resin was packed into the mold space as per the manufacturer instruction to prepare resin blocks. These heat cure resin blocks were cured as per the manufacturer instruction at

72⁰to 80⁰ centigrade for a period of 9 hours and bench cooled. The polymethyl metha acrylate blocks were then ground with 320-grit silicone carbide paper to remove surface irregularities and excess material.

PREPARATION OF MOLD SPACE FOR LINER PLACEMENT:

The two rectangular shaped acrylic blocks of 40 x 10 x 10mm and one steel die of 10 x 10 x 3mm were flaked with type II gypsum as follows. The 10 x 10 x 3mm steel die placed in-between the two acrylic blocks of 40 x 10 x 10mm (Fig. III). After the flaking procedure the die was removed to create a mold space (Fig.III) for soft liner.

PREPARATION OF GROUP A SAMPLES (FIG. IV):

The surfaces of the acrylic blocks to be bonded with soft liner were coated with primer R and dried with clean air, and then it was placed in the mold space. In-between the two acrylic blocks the auto polymerized silicone soft liners were packed into the mold space (Fig.III) as per the manufacturer instructions. After the packing procedure the flask was kept under bench press for 10 minutes to allow the liner to cure completely then the samples were removed from the mold space and the excess material were removed with sharp scalpel blade.

PREPARATION OF GROUP B SAMPLES (Fig. V):

The surface of the acrylic blocks to be bonded with soft liner were pretreated with methyl methacrylate for 180 seconds, and then the specimens were left to dry for 2 minutes. The primer R was applied gently to the methyl methacrylate treated surfaces with a brush and dried with clean air, and then acrylic blocks were placed into the mold space. In-between the two acrylic blocks as per the manufacturer instructions the auto polymerized silicone soft liners were mixed and packed into the mold space. After the packing procedure the flask was kept under bench press for 10 minutes to allow the liner to cure completely then the samples were removed from the mold space and the excess material were removed with sharp scalpel blade.

PREPARATION OF GROUP C SAMPLES (Fig. VI):

The polymethyl methacrylate blocks were placed into the mold space. In-between the two acrylic blocks as per the manufacturer instructions the auto polymerized acrylic soft liners were packed into the mold space. After the packing procedure the flask was kept under bench press for 10 minutes to allow the liner to cure completely then the samples were removed from the mold space and the excess material were removed with sharp scalpel blade.

PREPARATION OF GROUP D SAMPLES (Fig.VII):

The surface of the acrylic blocks to be bonded with soft liner were pretreated with methyl metha acrylate for 180 seconds, then the acrylic blocks were left to dry for 2minutes and then acrylic blocks were placed into the mold space. In-between the two acrylic blocks as per the manufacturer instructions the auto polymerized acrylic soft liners were packed into the mold space. After the packing procedure the flask was kept under bench press for 10 minutes to allow the liner to cure completely then the samples were removed from the mold space and the excess material were removed with sharp scalpel blade.

PEEL BOND STRENGTH

A total of 20 acrylic plates of dimensions 75 x 25 x 3mm were prepared in heat cured denture base resin. The polymethyl methacrylate plates were ground with 320-grit silicone carbide paper to remove surface irregularities and excess material. These twenty plates were then divided into five groups.

1. Group **E**
2. Group **F**
3. Group **G**
5. Group **H**

Each group contains 5 samples and each sample consists of one acrylic plate bonded with soft liner.

- Group E and G samples surfaces were not pretreated with methyl methacrylate.
- Group F and H samples surfaces were pretreated with methyl methacrylate for 180 seconds.
- Auto polymerized silicone soft liner were bonded to group E and F
- Auto polymerized acrylic soft liner were bonded to group G and H

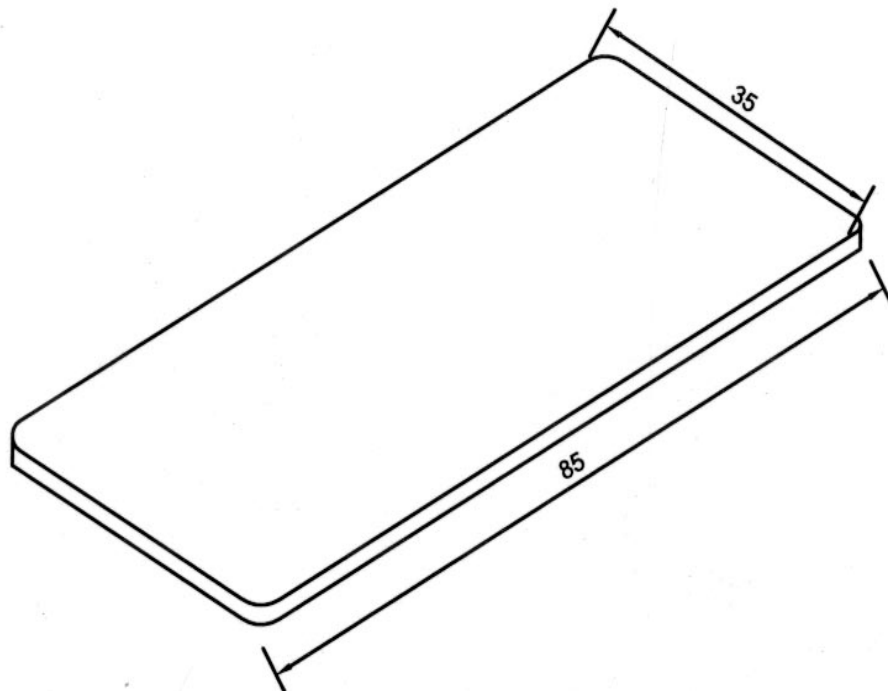
PREPARATION OF THE TEST SAMPLES:

Two rectangular steel dies were prepared and it has two parts.

1. LID (Fig. IX)
2. BASE (Fig. IX)

LID:

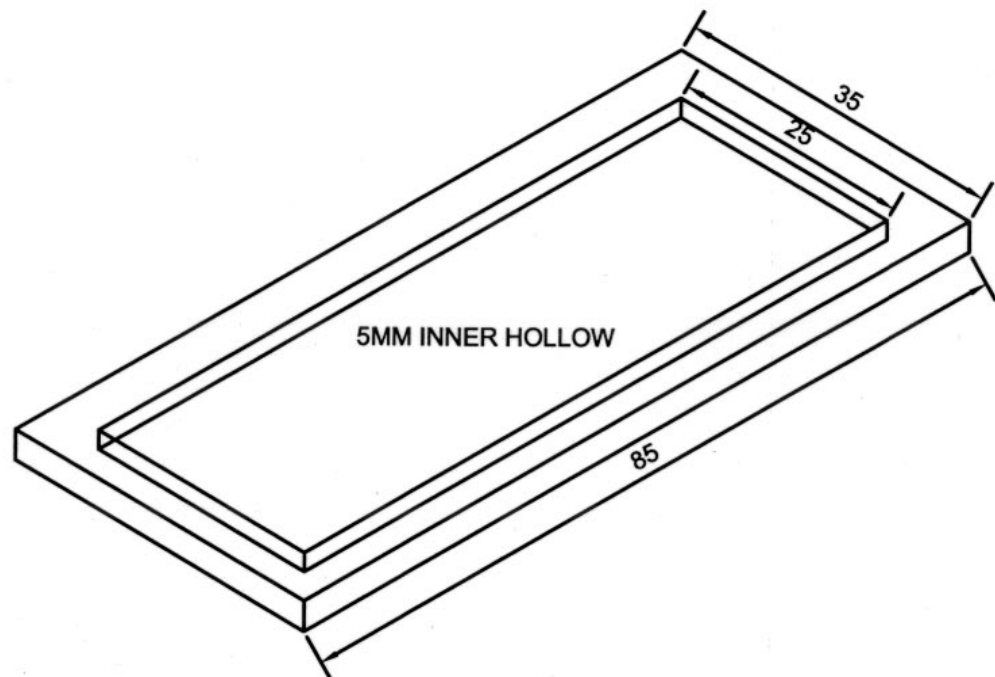
The dimension of the lid is 85mm length X 35mmwidth X 4mm thickness. The surfaces of the lid were smooth, flat and the corners were rounded.



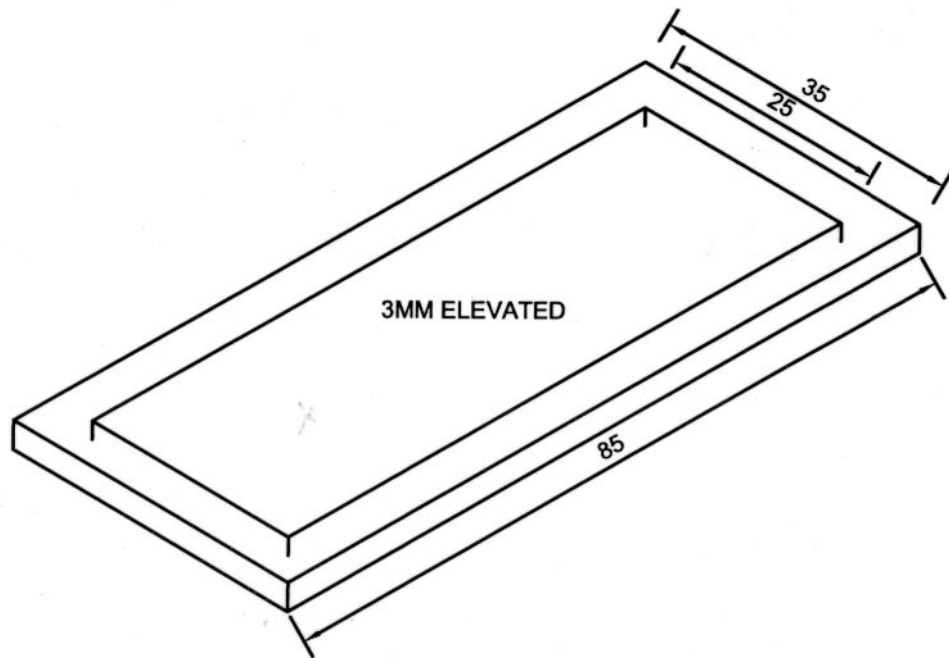
BASE:

Base metal die has two sides.

1. One side of the steel die, mold space was prepared for the dimension of 75mm length x 5mm depth x 25mm width. The surfaces of the steel die mold space were smooth, flat and with sharp edges. This mold space was used for soft liner attachment to the polymethyl methacrylate plate.



2. Other side of the steel die (Fig.X) has elevated rectangular slab having the dimension of 75mm length x 25mm width X 3mm height. The surfaces of the steel die mold space were smooth, flat and with sharp edges. This elevated side of the die was used for the preparation of acrylic plate.



PREPARATION OF ACRYLIC PLATES:

A modeling wax sheet was used to box the elevated side of the steel die (Fig.XI). Vaseline was applied over the die and die stone was mixed with recommended water powder ratio as per the manufacturer instruction and it was poured to create a mold space. A total number of twenty-die stone mold space (Fig.XII) having a dimension of 75mm x 25mm x 3mm were prepared. Molten wax was poured into the mold space and flasking was done by conventional technique. After dewaxing heat cure resin was packed into the mold space as per the manufacturer instruction to prepare resin plates. These heat cure resin plates were cured as per the manufacturer instruction at 72⁰ to 80 centigrade for a period of 9 hours and bench cooled. The polymethyl metha acrylate plates were retrieved from the flask and ground with 320-grit silicone carbide paper to remove surface irregularities and excess material(Fig.XIII). Out of the total surface area of the acrylic plate, the space having the dimensions of 50mm length X 25mm width was covered by polyethylene sheet and remaining portion of acrylic plate having the dimensions of 25mm length X 25mm width was left uncovered to facilitate the bonding of soft liner over this surface.

PREPARATION OF GROUP E SAMPLES:

The part of the acrylic plates to be bonded with soft liner were coated with primer R and dried with clean air then it was placed in the mold space of steel die. The acrylic plate occupies the mold space of 75mm length X 25mm width X 3mm depth and the rest of the mold space was left for the auto polymerized silicone soft liner which is packed over the acrylic plates as per the manufacturer instructions (Fig.XIV) and the soft liner was covered by polyethylene sheet over that lid was placed and it was compressed for 10 minutes under the bench press, the excess materials were removed by scalpel blade. In the prepared sample out of total dimension of 75mm length X 25mm width X 2mm thickness only 25mm length X 25mm width of the liner was bonded to the acrylic plate. The remaining part of the soft liner was not bonded (Fig. XV), to facilitate the attachment with testing machine.

PREPARATION OF GROUP F SAMPLES:

The surface of the acrylic plates to be bonded with soft liner were pretreated with methyl metha acrylate for 180 seconds, and then the specimens were left to dry for 2minutes. The primer R was coated gently

over the treated surfaces with a brush and dried with clean air and then polymethyl methacrylate plate was placed in the mold space of steel die. The acrylic plates occupies the space of 75mm length X 25mm width X 3mm depth and the rest of the mold space was left for the auto polymerized silicone soft liner, which is packed over the acrylic plates as per the manufacturer instructions and the soft liner was covered by polyethylene sheet over that lid was placed and it was compressed for 10 minutes under the bench press, the excess materials were removed by scalpel blade. In the prepared sample out of total dimension of 75mm length X 25mm width X 2mm thickness only 25mm length X 25mm width of the liner was bonded to the acrylic plate. The remaining part of the soft liner was not bonded, to facilitate the attachment with testing machine.

PREPARATION OF GROUP G SAMPLES:

The acrylic plate was placed in the mould space of steel die and it occupied the space of 75mm length X 25mm width X 3mm depth and the rest of the mold space was left for the auto polymerized acrylic soft liner which is packed over the acrylic plates as per the manufacturer instructions and the soft liner was covered by polyethylene sheet over that lid was placed and it was compressed for 10 minutes under the bench

press, the excess materials were removed by scalpel blade. In the prepared sample out of total dimension of 75mm length X 25mm width X 2mm thickness only 25mm length X 25mm width of the liner was bonded to the acrylic plate. The remaining part of the soft liner was not bonded, to facilitate the attachment with testing machine.

PREPARATION OF GROUP H SAMPLES:

The surface of the acrylic plates to be bonded with soft liner were pretreated with methyl metha acrylate for 180 seconds, and then the specimens were left to dry for 2minutes and it was placed in the mold space of steel die. It occupied the space of 75mm length X 25mm width X 3mm depth and the rest of the mold space was left for the auto polymerized acrylic soft liner which is packed over the acrylic plates as per the manufacturer instructions and the soft liner was covered by polyethylene sheet over that lid was placed and it was compressed for 10 minutes under the bench press, the excess materials were removed by scalpel blade. In the prepared sample out of total dimension of 75mm length X 25mm width X 2mm thickness only 25mm length X 25mm width of the liner was bonded to the acrylic plate. The remaining part of the soft liner was not bonded, to facilitate the attachment with testing machine.

SAMPLES PREPARATION FOR SCANNING ELECTRON MICROSCOPE

Mold space was created from one steel die having the dimension of 10mm length X 10mm width X 3mm thickness by using addition silicone putty material. Wax blocks were prepared by pouring the molten wax into the silicone mould space. A total of two wax patterns were prepared, The wax patterns were then flaked by conventional technique. After dewaxing heat cure resin was packed into the mold space as per the manufacturer instruction to prepare acrylic resin blocks. These heat cure resin blocks were cured as per the manufacturer instruction at 72⁰ to 80⁰ centigrade for a period of 9 hours and bench cooled. The polymethyl metha acrylate blocks were then ground with 320-grit silicone carbide paper to remove surface irregularities and excess material.

- One-heat cure resin block was treated by methyl metha acrylate for 180 seconds; other one was not treated by methyl metha acrylate.

PREPARATION OF SAMPLES FOR SCANNING ELECTRON MICROSCOPE

Specimens requiring to be studied under scanning electron microscope should be made electro conductive. In order to make the specimen's electro conductive, the specimens were gold sputtered with the help of sputter coating machine before subjecting them to screening in a scanning electron microscope.

TESTING THE SAMPLES

Tensile and peel bond strength tests were carried out with a universal testing machine named Lloyed instrument. The universal testing machine was connected to an IBM computer. In peel test, the stress is limited to a line at the edge of the joint as the fibers of the soft liners are stretched and pulled away whereas in the tensile test the whole cross sectional area of the bonded surface is under stress.

TENSILE BOND STRENGTH

The specimen was fixed to the grip of the Lloyed machine and pulled in either way at a crosshead speed of 5mm/minute was used for this test (Fig.VIII). The maximum tensile load before failure was

recorded for each specimen. Tensile bond strength was calculated by the following formula²⁰

$$\text{Tensile bond strength} = \frac{\text{Maximum load (N)}}{\text{Cross sectional area (mm}^2\text{)}}$$

The crosshead speed was same for all samples in order to standardize the procedure.

PEEL BOND STRENGTH

The specimen was placed in Lloyd universal testing machine at 180-degree angle with the polymethyl metha acrylate plate portion in the lower clamp and the soft liner was in the upper clamp. The machine was operated at crosshead speed of 5mm/minute (Fig.XVI). The maximum load and the soft liner stretched length before failure was recorded for each specimen. The peel bond strength was calculated by the following formula²⁰

$$\text{Peel bond strength} = \frac{F}{W} \left(\frac{1+\lambda}{2} + 1 \right) \left\{ \frac{n}{\text{mm}} \right\}$$

The crosshead speed was same for all samples in order to standardize the procedure.

FIGURE I – G. C Reline Soft - SILICONE SOFT LINER



FIGURE IA – Coe – Soft - ACRYLIC SOFT LINER



TENSILE BOND

FIGURE II



FIGURE III



FIGURE IV – GROUP A SAMPLES

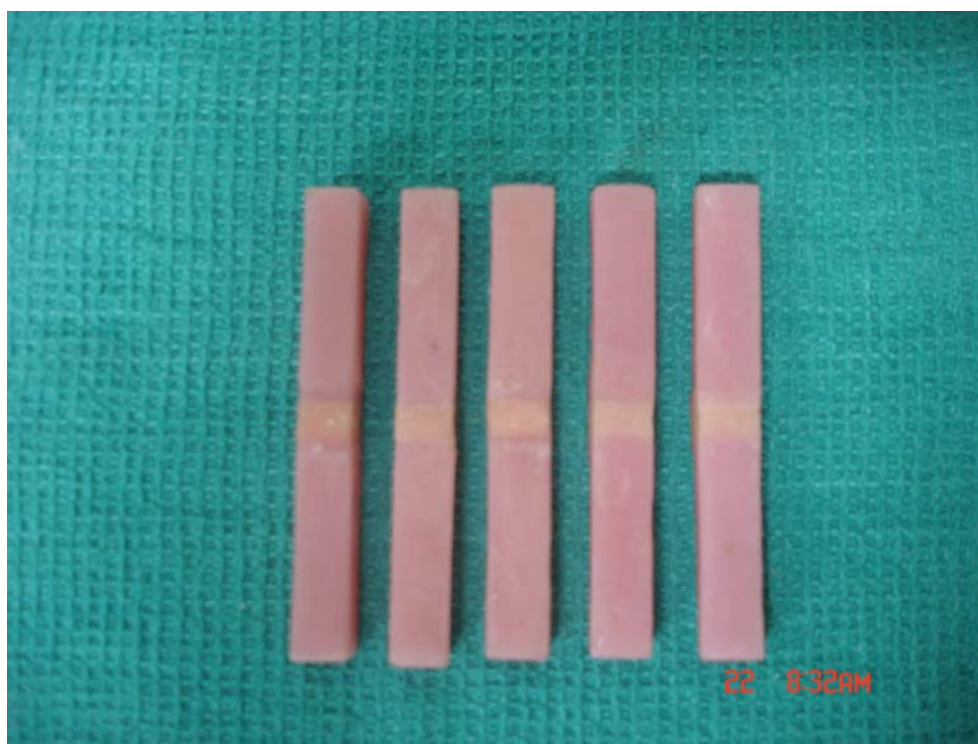


FIGURE V – GROUP B SAMPLES



FIGURE VI - GROUP C SAMPLES



FIGURE VII – GROUP D SAMPLES

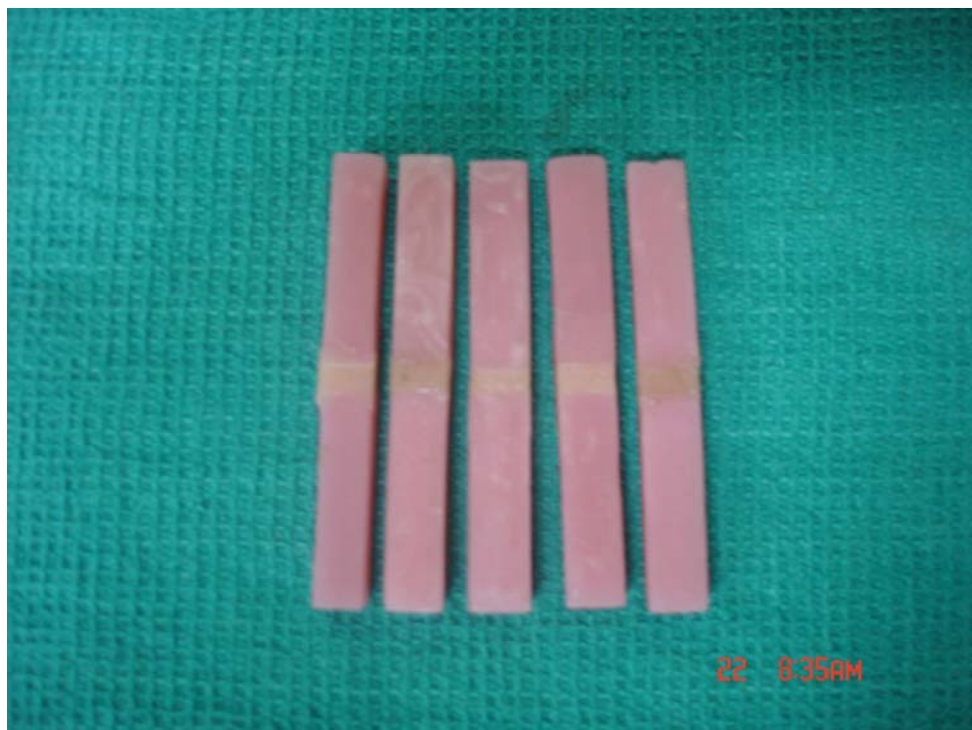


FIGURE VIII



PEEL BOND STRENGTH

FIGURE IX



FIGURE X



FIGURE XI



FIGURE XII



FIGURE XIII



FIGURE XIV



FIGURE XV



FIGURE XVI



RESULTS

An invitro study was conducted to evaluate the peel and tensile bond strength of some of the commercially available soft liners with acrylic denture base and the effect of surface pretreatment of denture base with methyl metha acrylate. In addition to this the surface topography of the heat cure denture base is observed before and after surface pretreatment with methyl metha acrylate by scanning electron microscope. Tensile and peel bond strength tests were carried out with a universal testing machine named Lloyed instrument. Five samples from each group were tested at a constant cross head speed of 5mm/min¹². The tensile and peel bond strength were recorded. All data's were tabulated and statistical comparisons were made by one-way ANOVA variance and Tukey-HSD multiple range comparison test.

TENSILE BOND STRENGTH:**TABLE - I**

GROUP A - SILICONE SOFT LINER (Untreated with methyl methacrylate)

Sample No.	Peak load (N)	Tensile bond strength (N/mm)
1.	132	1.32
2.	130	1.30
3.	131	1.31
4.	133	1.33
5.	134	1.34
Mean	132	1.32

TABLE - II

GROUP B - SILICONE SOFT LINER (Treated with methyl methacrylate)

Sample No.	Peak load (N)	Tensile bond strength (N/mm)
1.	210	2.1
2.	210	2.1
3.	218	2.18
4.	223	2.23
5.	200	2.0
Mean	212	2.1

TABLE –III

GROUP C - ACRYLIC SOFT LINER (Untreated with methyl methacrylate)

Sample No.	Peak load (N)	Tensile bond strength (N/mm ²)
1.	23	0.23
2.	24	0.24
3.	23	0.23
4.	25	0.25
5.	24	0.24
Mean	23.8	0.24

TABLE – IV

GROUP D - ACRYLIC SOFT LINER (Treated with methyl methacrylate)

Sample No.	Peak load (N)	Tensile bond strength (N/mm ²)
1.	26	0.26
2.	28	0.28
3.	28	0.28
4.	23	0.23
5.	28	0.28
Mean	26.6	0.27

TABLE - V**STATISTICAL RESULT OF TENSILE BOND STRENGTH**

Sl. no	Group	Mean	SD	P- value
1	A	1.32 ^b	0.02	<0.001**
2	B	2.12 ^c	0.09	
3	C	0.24 ^a	0.01	
4	D	0.27 ^a	0.02	

Note: 1. ** Denotes significant at 1% level

2. Different alphabet between the groups denotes significant at 5% level

PEEL BOND STRENGTH**TABLE – VI**

GROUP E - SILICONE SOFT LINER (Untreated with methyl methacrylate)

Sample No.	Peak load (N)	Soft liner stretched length (mm)	Peel bond strength (N/mm)
1	40	57	3.31
2	42	62	3.76
3	39	62	3.30
4	40	60	3.36
5	41	57	3.39
Mean	40.4	59.6	3.42

TABLE – VII

GROUP F - SILICONE SOFT LINER (Treated with methyl methacrylate)

Sample No.	Peak load (N)	Soft liner stretched length (mm)	Peel bond strength (N/mm)
1	50	62	4.24
2	55	60	4.62
3	52	57	4.30
4	50	60	4.20
5	50	62	4.24
Mean	51.4	60.2	4.32

TABLE - VIII

GROUP G - ACRYLIC SOFT LINER (Untreated with methyl methacrylate)

Sample No.	Peak load (N)	Soft liner stretched length (mm)	Peel bond strength (N/mm)
1	10	110	1.04
2	12	100	1.20
3	11	120	1.18
4	12	97	1.18
5	10	127	1.10
Mean	11	110.8	1.14

TABLE - IX

GROUP H - ACRYLIC SOFT LINER (Treated with methyl methacrylate)

Sample No.	Peak load (N)	Soft liner stretched length (mm)	Peel bond strength (N/mm)
1	10	110	1.04
2	12	123	1.31
3	9	127	0.99
4	9	95	0.88
5	11	97	1.08
Mean	10.2	110.4	1.06

TABLE – X

STATISTICAL RESULTS OF PEEL BOND STRENGTH

Sl. no	Group	Mean	SD	P- value
1	E	3.42 ^b	0.19	<0.001**
2	F	4.32 ^c	0.17	
3	G	1.06 ^a	0.16	
4	H	1.14 ^a	0.07	

Note: 1. ** Denotes significant at 1% level

2. Different alphabet between the groups denotes significant at 5% level

SCANNING ELECTRON MICROSCOPE RESULTS

Fig-A untreated surface of the denture base resin ground with 320-grit silicone carbide paper.

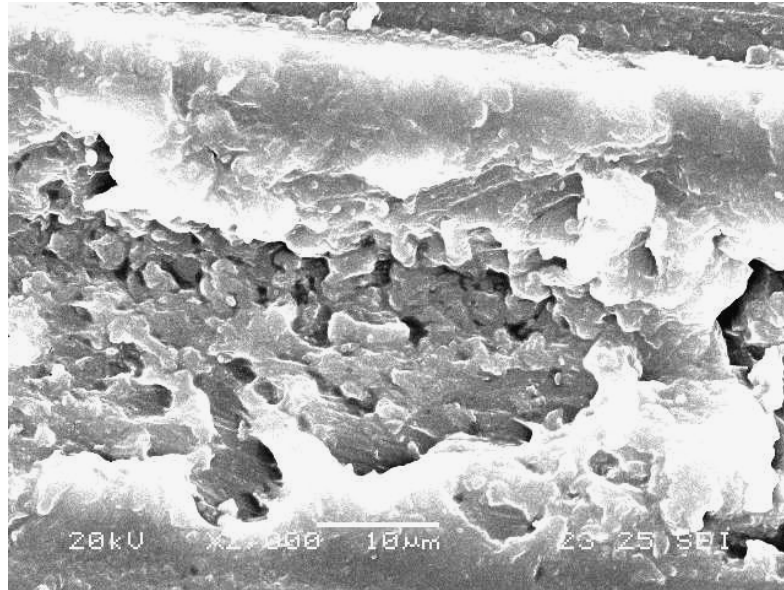
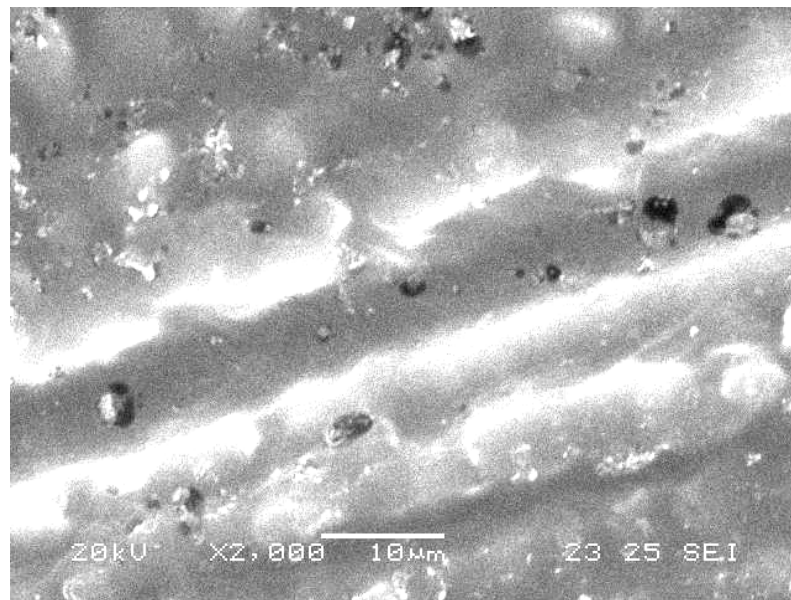


Fig-B treated surface of the denture base resin with methyl methacrylate



BAR DIAGRAM

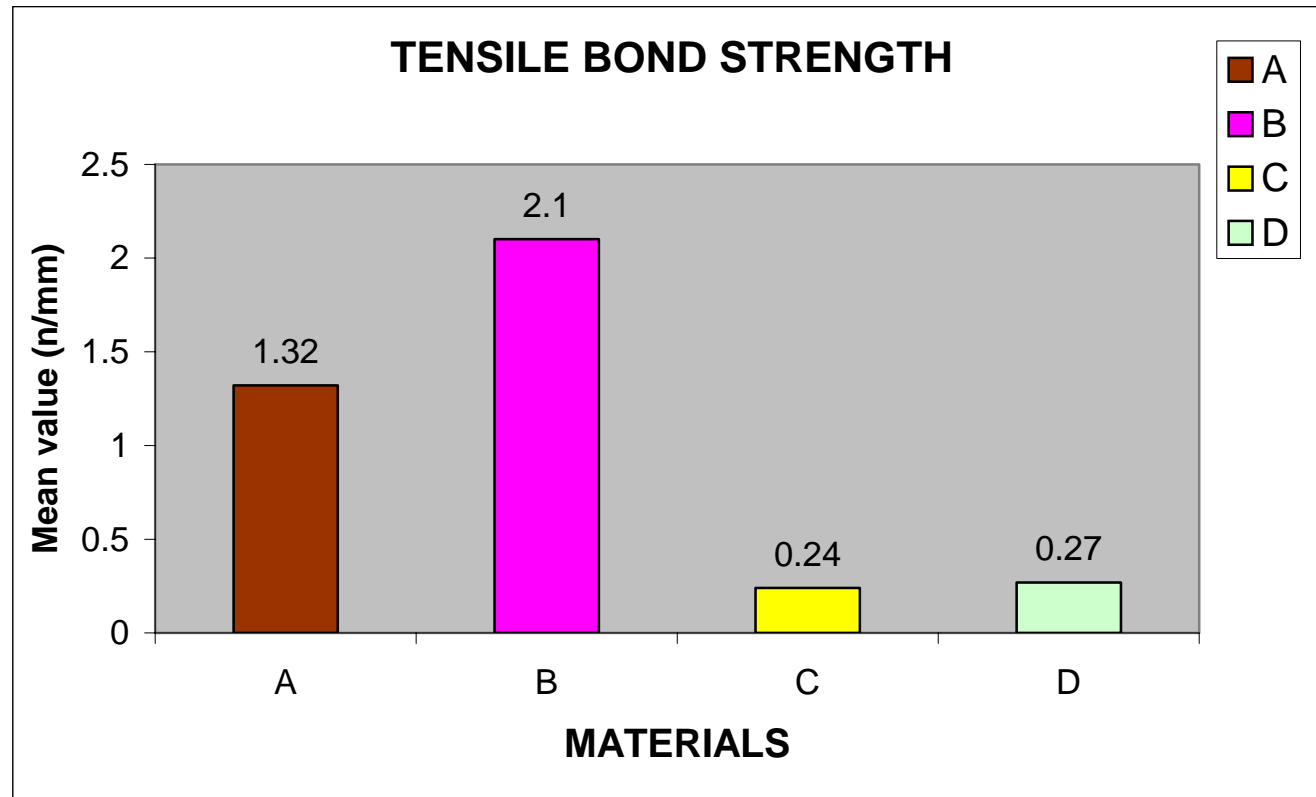


FIGURE C

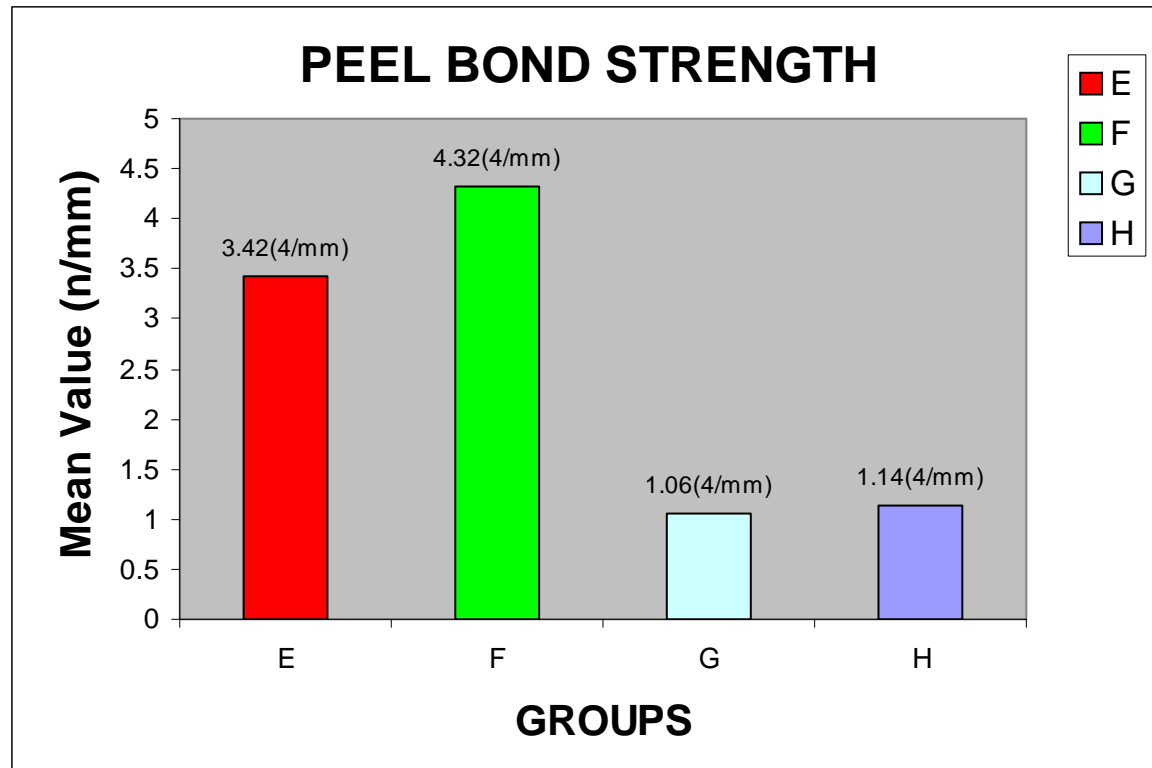


FIGURE D

Table – I show the peak load 132(N) tensile bond strength and mean value 1.32 N/mm^2 of group-A samples of silicone soft liner without surface treatment of denture base.

Table – II show the peak load 212(N) tensile bond strength and mean value 2.1 N/mm^2 of group-B samples of silicone soft liner with surface treatment of denture base.

Table – III show the peak load 23.8(N) tensile bond strength and mean value 0.24 N/mm^2 of group-C samples of acrylic soft liner without surface treatment of denture base.

Table – IV show the peak load 26.6(N) tensile bond strength and mean value 0.27 N/mm^2 of group-C samples of acrylic soft liner with surface treatment of denture base.

Table – V shows the statistical analysis of tensile bond strength of silicone and acrylic soft liner bonded to treated and untreated surface of denture base. ** Denotes significant at 1% level and different alphabet between the groups denotes significant at 5% level.

Table – VI show the peak load 40.4(N), stretched length 59.6mm and peel bond strength mean value 3.42 N/mm² of group-E samples of silicone soft liner without surface treatment of denture base.

Table – VII show the peak load 51.4(N), stretched length 60.2mm and peel bond strength mean value 4.32 N/mm² of group-E samples of silicone soft liner with surface treatment of denture base.

Table – VIII show the peak load 11(N), stretched length 110.8mm and peel bond strength mean value 1.14 N/mm² of group-G samples of acrylic soft liner without surface treatment of denture base.

Table – IX show the peak load 10.2(N), stretched length 110.4mm and peel bond strength mean value 1.06 N/mm² of group-H samples of acrylic soft liner with surface treatment of denture base.

Table – X shows the statistical analysis of peel bond strength of silicone and acrylic soft liner bonded to treated and untreated surface of denture base. ** Denotes significant at 1% level and different alphabet between the groups denotes significant at 5% level.

Fig-A scanning electron microscope investigation result shows scratches, pores and depressions.

Fig-B scanning electron microscope investigation result shows the prominent pores and smoother surface texture than the figure-A. This may be attributed to swelling of the superficial layer of the denture base.

DESCRIPTION OF BAR DIAGRAM

Fig-C : Bar diagram represents Tensile bond strength of acrylic and silicone softliner bonded to treated and untreated surface of the denture base tested in this study.

Fig-D : Bar diagram represents Peel bond strength of acrylic and silicone softliner bonded to treated and untreated surface of the denture base tested in this study.

STATISTICAL ANALYSIS

- Overall comparison of groups was done using one-way analysis of variance (ANOVA) with significant at 1%. Level.
- Comparison with in the groups was done using multiple range tests Tukey-HSD test with significant at 5% level.

INTERPRETATION OF RESULTS

- **Group A** samples show lesser value than the group B samples, which is statistically significant
- **Group A** samples show higher values than the group C and D samples, which are statistically significant
- **Group B** samples show higher values than the group A, group C and group D samples, which are statistically significant.
- From the results it was found that between the group C and group D samples, the values are not statistically significant.
- **Group E** samples show lesser value than the group F samples, which is statistically significant
- **Group E** samples show lesser value than the group F samples and higher values than the group G and H, which are statistically significant
- **Group F** samples show higher values than the group E, group G and group H samples, which are statistically significant
- From the results it was found that between the group G and group H samples, the values are not statistically significant.

DISCUSSION

Resilient soft liners are widely used in prosthetic dentistry as an adjunct to removable prosthesis to restore the health of the inflamed and abused denture supporting tissues¹⁷. Use of these materials as an adjunct in the successful treatment proved appreciable prognosis of patients with complete and removable partial dentures⁴². These materials are commonly used for patients with resorbed mandibular alveolar ridge, thin and nonresilient mucosal tissue, maxillofacial defect, patients unable to tolerate the hardness of heat-polymerized acrylic resin denture base⁴² and medically compromised individuals. Excess and uneven pressure on mental foramen; sharp ridges (knife edge); thin, atrophic mucosa; bony undercuts. In addition to this irregular bone resorption; poor fit of the denture base; Bruxism and /or debilitating diseases²³-(diabetes mellitus) are also can be included.

Resilient soft liners are used to distribute functional loads by optimizing adaptation of the denture base to residual ridges, to reduce the stress concentration on residual ridge and to make dentures more comfortable⁴².

However one of the major drawbacks of soft liners is the lack of durable bond to the denture base. The bond between the heat polymerized acrylic denture base and the soft liners not found to be long lasting and requiring repeated relines.

Hence understanding the chemistry of the bonding of soft liners with acrylic resin along with the nature of the bond and mechanism of bond failure will help us to overcome the problem and render better service to the patients to be rehabilitated by removable prosthesis.

Various workers have done elaborate study on the bond strength of the soft liners with acrylic denture base by subjecting them to a variety of studies, which include peel, tensile, shear bond strength and creep test, currently most of the clinicians prefer the autopolymerized soft lining materials as an alternative to heat cured soft liners because of their chairside usage, easy application and less laboratory procedures.

The present study was under taken to evaluate the tensile & peel bond strength of two commercially available soft liners G.C reline soft-Auto polymerized silicone soft liner & Coe-soft-Auto polymerized acrylic soft liner with heat activated acrylic denture base samples. The bonding ability of these resilient soft liners with pretreated and untreated

surfaces of acrylic denture base was also evaluated in this study. In addition to this the surface topography of the heat cure acrylic denture base before and after surface pretreatment with methyl metha acrylate for 180 seconds was evaluated with scanning electron microscope. The surface of acrylic denture base samples were pretreated with methyl methacrylate for about 180 seconds to improve the bonding ability with soft liners.

From the result of this tensile and peel bond strength test, it was found that the silicone soft liner bonded to the treated surface of the denture base resin with methyl methacrylate for 180 seconds exhibited higher bonding ability than the silicone soft liner bonded to the untreated surface of the acrylic denture base. Mode of bond failure was also observed among the groups of the treated and untreated surface of the denture base. The pretreated surface of the denture base demonstrated primarily cohesive type of failure and the untreated surface shows primarily adhesive type of failure. Both the samples, which are subjected to the bond tests, were abraded with 320 grit silicone carbide paper.

The scanning electron microscope study on the treated and untreated surface of the denture base resin shows different type of surface texture.

- The untreated surface of the acrylic denture base that is abraded with 320-grit silicone carbide paper showed scratches, pores and depressions.
- The pretreated surface of the acrylic denture base with methyl methacrylate for 180 seconds showed smoother surface texture. In addition to this the pores created on the surface of the denture base were seemed to be prominent and this may be attributed to swelling of the superficial layer of denture base.

The result of this study show that the bond strength of silicone soft liner bonded to the treated surface of the acrylic denture base with methyl metha acrylate for 180 seconds was improved appreciably than untreated samples.

The results of this study was correlated with that of previous studies done by various workers who had done elaborate studies and it was understood that the swelling of the outer layer of denture base by MMA wetting and the penetration of the adhesive more effectively into the pores created improve the bonding ability between the denture base and soft liner.^{25,42,8}

Leles et al²⁵ used different chemical surface treatments to increase the bond strength between a chairside reline resin and a denture base material.

Y. Sinasi Sarac⁴² et al used airborne-particle abrasion and methyl methacrylate wetting as a denture base resin pretreatment to examine the effect on microleakage between silicones based resilient liner and denture base resin by means of the radioactive tracer, thallium-201. The authors reported that the swelling of the outer denture base by MMA wetting and the penetration of the adhesive more effectively reduced the leakage of fluids within this interface compared to airborne-particle.

Duygu Sarac⁸ found that treating the denture base resin surface with methyl methacrylate for 180 seconds prior to adhesive application reduced the microleakage and increased the bond strength when using silicone based resilient liners.

From the results of tensile and peel bond strength between the silicone and acrylic soft liner, the silicone soft liner exhibited higher value than the acrylic soft liner. The mode of failure in acrylic soft liner bonded to both treated and untreated surface of the denture base was completely cohesive and the stretched length of the acrylic soft liner was found to be high in a lesser load where as silicone soft liners needed more load. It may be attributed to the different composition of the materials and the better elastic behavior of silicone soft liner. The life expectancy of acrylic soft liner was about 6 months and that of the silicone soft liner was about one year. This could be attributed to the leaching out of the plasticizer present in the acrylic soft liners with in short period when

compare to the silicone soft liner which exhibited better elastic property than the acrylic soft liner.

The previous study report was also showed that the autopolymerized acrylic soft liner bond strength values are lesser than silicone based and heat-cured acrylic soft liner⁴

The tensile and peel bond strength of acrylic soft liner bonded to treated surface of the acrylic denture base doesn't shows any significant difference with acrylic soft liner bonded to the untreated surface of the acrylic denture base. This may be due to inadequate depth of penetration of autopolymerizing soft liners over the surface of acrylic denture base. According to literatures the percentage of free monomer in autopolymerized resin is found to be more than heat cured resin and this could be attributed cause for the inadequate depth of penetration.

The results of the present study revel that treating the acrylic denture base with methyl methacrylate improved the efficiency of bonding between a silicone-based resilient lining material and denture base. The statistical analysis of the bond strength values showed no significant difference between the acrylic soft liner bonded to the treated surface of the acrylic denture base and the untreated surface of the

denture base. Although the chemical nature of denture base and acrylic soft liner is same, the debonding of liner at less load may be due to less elastic behaviour than silicone soft liner. A notable limitation of this study is the use of only one type of silicone-based resilient lining material was deployed in the tests. Thus further elaborate study may be much useful to evaluate the effects of the denture base surface pretreatments on the bond strength of different silicone based soft lining materials.

The materials used in conjunction with soft liners Primer. R & monomers may cause partial dissolution of accompanying denture bases. So, the further studies will also helpful to evaluate whether theses materials affect the strength of the acrylic denture base.

SUMMARY

An invitro study was conducted to evaluate the peel and tensile bond strength of some of the commercially available soft liners with acrylic denture base and the effect of surface pretreatment of acrylic denture base with methyl metha acrylate. In addition to this the surface topography of the heat cure denture base is also observed before and after surface pretreatment with methyl metha acrylate by scanning electron microscope.

Two commercially available autopolymerized soft liners by name G.C Reline Soft silicone based soft liner and Coe-Soft acrylic resilient soft liner and Acrylan-H heat cured denture base material were selected for this study purpose. The test samples and testing methods were carefully standardized.

The results of the present study revealed that treating the acrylic denture base with methyl methacrylate improved the efficiency of bonding between the silicone-based resilient lining material and the acrylic denture base. Where as the bond strength values of acrylic soft liners with denture base showed no significant improvement between the acrylic soft liner bonded to the treated surface of the acrylic denture base and the untreated surface of the acrylic denture base.

The materials used in conjunction with soft liners are Primer. R & methyl methacrylate may have influence in partial dissolution of accompanying denture bases. So the further studies will helpful to evaluate whether these materials impair the strength of the acrylic denture base.

CONCLUSION

Within the limitations of this in vitro study, the following conclusion were drawn:

1. Treating the acrylic denture base surface with methyl methacrylate for 180 seconds significantly improved the bond strength of silicone based soft liner to the acrylic denture base. Considering the results of both tensile and peel bond strength test together, the use of methyl methacrylate pretreatment for 180 seconds was found to be the most effective method to increase bonding ability of the silicone soft liner to acrylic denture base.

2. The tensile and peel bond strength of acrylic soft liner bonded to pretreated surface of the acrylic denture base doesn't shows any significant improvement with acrylic soft liner bonded to the untreated surface of the acrylic denture base.

3. The results of scanning electron microscope shows wetting of the acrylic denture base with methyl methacrylate for 180 seconds, smoothened the acrylic denture base surface and the pores on the surface were found to be more prominent than the untreated surface of the acrylic denture base.

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